Entergy

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Fred Dacimo
Site Vice President

June 5, 2007
Indian Point 3
Docket No. 50-286
NL-07-053

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, D.C. 20555-0001

Subject: Licensee Event Report # 2007-002-00, "Automatic Reactor Trip Due to a Turbine-Generator Trip Caused by a Fault on the 31 Main Transformer Phase B High Voltage Bushing"

Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc. (ENO) hereby provides Licensee Event Report (LER) 2007-002-00. The attached LER identifies an event where the reactor automatically tripped while critical, which is reportable under 10 CFR 50.73(a)(2)(iv)(A) . This condition has been recorded in the Entergy Corrective Action Program as Condition Report CR-IP3-2007-01834.

There are no new commitments identified in this letter. Should you have any questions regarding this submittal, please contact Mr. T. R. Jones, Manager, Licensing at (914) 734-6670.

Sincerely,

Fred R. Dacimo
Site Vice President
Indian Point Energy Center

cc: Mr. Samuel J Collins, Regional Administrator, NRC Region I
NRC Resident Inspector's Office, Indian Point 3
Mr. Paul Eddy, New York State Public Service Commission
INPO Record Center

IE22
NRC/NRR

NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES: 6/30/2007

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-I0202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
INDIAN POINT 3	05000-286	1 OF 5

4. TITLE Automatic Reactor Trip Due to a Turbine-Generator Trip Caused by a Fault on the 31 Main Transformer Phase B High Voltage Bushing

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV. NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
4	06	2007	2007-	002 -	00	6	5	2007	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE

1

10. POWER LEVEL

92%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER *(Include Area Code)*
Stephen Manzione, Program & Component Engineering Supervisor	(914) 734-6772

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	EL	XFMR	W121	Y					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

16. ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced type written lines)*

On April 6, 2007, at 1109 hours, an automatic reactor trip (RT) occurred due to a turbine-generator trip as a result of a fault on the 31 main transformer. All control rods fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser. There was no radiation release. The Emergency Diesel Generators did not start as adequate offsite power remained available. Two of three 138 kV offsite power substation feeders tripped as a result of the event. The Auxiliary Feedwater System automatically started as expected due to Steam Generator low level from shrink effect. Control Room (CR) operators were notified of a fire at the 31 main transformer with the fire protection deluge system actuated. The plant fire brigade responded to the fire and applied foam. The fire brigade leader reported to the CR the fire was extinguished at 1121 hours. The CR was notified at approximately 1140 hours that a visible explosion had previously occurred. Based on the report of an explosion, the CR declared a Notice of Unusual Event (NUE) in accordance with the emergency plan which was terminated at 1254 hours. The direct cause of the RT was due to the actuation of the 86P and 86BU relays that sensed a fault from the failure of 31 main transformer 345 kV phase B bushing. The most probable cause was a design weakness associated with the type bushing used in the Phase B bushing. Significant corrective actions included replacement of 31 main transformer, and inspection, repair and replacement of damaged components as required associated with the 32 main transformer, the unit auxiliary transformer, and high voltage components. The event had no effect on public health and safety.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Indian Point Unit 3	05000-286	2007	- 02 -	00	2 OF 5

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

Note: The Energy Industry Identification System Codes are identified within the brackets {}.

DESCRIPTION OF EVENT

On April 6, 2007, during a hold at approximately 92% reactor power, after power ascension from an outage, an automatic reactor trip (RT) {JC} occurred at 1109 hours, due to a turbine-generator trip as a result of a fault on the 31 main transformer {EL}. All control rods {AA} fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. There was no radiation release. The Emergency Diesel Generators (EDG) {EK} did not start as adequate offsite power remained available. Two of three 138 kV offsite power feeders to the Buchanan substation {FK} tripped as a result of the event. The Auxiliary Feedwater (AFW) System {BA} automatically started as expected due to Steam Generator (SG) {AB} low level from shrink effect. An investigation into the cause of the event and a post transient evaluation was initiated.

Prior to the event all Control Rods were fully withdrawn from the reactor core (except Control Bank D) and in manual, both Main Boiler Feedwater Pumps (MBFPs) {SJ} were in service, AFW Pumps (AFWPs) were in standby, the EDGs were in standby, and off-site power was in service. The plant was holding at approximately 92% reactor power for testing in accordance with 3PT-Q87B, "Channel Functional Test of Reactor Coolant Temperature Channel 421." A catastrophic fault occurred on the 31 transformer (XFMR} phase B bushing which was sensed by the generator protection system primary and backup lockout relays {86P and 86BU} and a turbine-generator trip signal was initiated that resulted in a RT. An investigation in the transformer yard discovered a failed 345 kV phase B bushing on the 31 main transformer and a fire with the transformer fire protection deluge system {KP} actuated. The 31 main transformer fire was reported to the control room (CR) at approximately 1111 hours. Subsequently, the CR Shift Manager (SM) directed sounding of the fire alarm and dispatched the fire brigade (FB). The fire brigade leader reported to the CR, at approximately 1121 hours, that the fire was extinguished but the FB was continuing to apply foam. The fire was extinguished in less than 15 minutes therefore, the Emergency Plan (EP) Emergency Action Level (EAL) 8.2.1 was not applicable for declaration of an unusual event. However, at approximately 1140 hours, the CR SM received reports that personnel saw an explosion occur at the main transformer. Based on the verbal report of an explosion, the entry condition (explosion) was met for EP EAL 8.2.2 and a Notification of Unusual Event (NUE) was declared at approximately 1143 hours. The NUE was terminated at 1254 hours. On April 6, 2007, at 1159 hours, a one hour emergency notification per 10CFR50.72(a)(1)(i) was made to the NRC (Log Number 43272) for declaration of an NUE based on EP EAL 8.2.2. At 1440 hours, an update notification was made to report a four hour non-emergency notification for a RT while critical that included the eight hour non-emergency notification for actuation of the AFW system. The RT was reported under 10 CFR 50.72(b)(2)(iv)(B) and the AFW actuation reported under 10 CFR 50.72(b)(3)(iv)(A). The event was recorded in the Indian Point corrective action program (CAP) as CR-IP3-2007-01834. The trip of the breakers for two offsite feeders to the Buchanan substation was recorded in CR-IP2-2007-01533.

The 31 Main transformer, manufactured by Westinghouse {W120}, is one of two main generator output transformers designed to step up the three phase 22,000 volts output by the generator to 345,000 volts for power transmission to the electric power grid. The 32 main transformer was manufactured by General Electric (GE).

The failed phase B high voltage bushing is one of three oil filled insulated conductors for connecting the transformer internal output to the exterior high voltage transmission lines. The phase B bushing is a General Electric {G080} Type U oil filled condenser bushing, class #HRL260H, Series #1635523. The phase B bushing was installed as a replacement in 1976. The GE type U bushing design was found to have deficiencies which were documented throughout the industry. The phase A and C bushings are Westinghouse Type O bushings that were installed as replacements in 1980. Required maintenance and testing was performed and documented in the Preventive Maintenance (PM) program. A 6-year inspection of the 31 transformer was performed during the March 2007 refueling outage. Testing performed during the inspection included Doble Power Factor (PF) testing of the high voltage bushings. PF testing is a high voltage test used to determine the insulation integrity of dielectric insulation. Testing results indicated that bushing H2 on B phase of the 31 main transformer had elevated power factor readings. However, the readings were not above the transformer manufacturer action values to remove it from service based on the acceptance criteria. The bushing thermography (temperature) and Doble PF (insulation integrity) tests values were within acceptable limits prior to the event. Bushing inspections prior to the event found no leaks or porcelain insulation deficiencies. A check with Consolidated Edison for any grid disturbances or system faults that may have initiated the failure determined there were none.

Cause of Event

The direct cause of the RT was a turbine-generator trip due to actuation of generator protection system primary and backup lockout relays (86P, 86BU) that sensed a fault from a failure of the 31 main transformer 345 kV phase B bushing. The root cause was indeterminate as the catastrophic failure destroyed most of the evidence. Engineering postulates that the bushing fault developed internal to the bushing possibly due to thermal cycling of the bushing during its years of service that lead to gas bubbles (voids) in the bushing oil. The gas bubbles resulted in dielectric breakdown due to partial discharge until the breakdown was severe enough to result in failure to condense the voltage. The 345 kV then exited at the weakest point and arced to the steel transformer tank leaving a hole in the bushing conductor and rapid increase in combustible gases. The most probable cause was a design weakness associated with condenser type high voltage GE bushings used in Phase B whose design develops problems affecting dielectric insulation. Documented GE design weaknesses included: 1) design flaw where gaps existed at the ends of the internal insulation paper/core allowing for the formation of gas bubbles leading to partial discharge and increased dielectric losses, 2) the bushing condenser design incorporated alternate paper layers printed and plain where the ink developed capacitance properties allowing for voltage tracking across the paper causing corona action and burning, 3) the bushing flex seal design for thermal cycling would move and crack resulting in compromise of the seal, 4) age of the phase B GE Type U bushing which was an original early design with 30 years of operation.

Corrective Actions

The following corrective actions have been or will be performed under Entergy's Corrective Action Program to address the cause and prevent recurrence:

- The 31 main transformer was replaced with a spare transformer that uses a different bushing design.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Indian Point Unit 3	05000-286	2007	- 02 -	00	4 OF 5

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

- Testing and inspection was performed on the 32 main transformer, the replacement transformer for the failed 31 main transformer, the unit auxiliary transformer and Hi voltage equipment. Cleaning and replacement as necessary of degraded and failed components was performed.
- Engineering will establish Doble acceptance criteria for large transformers and include the criteria in applicable documents. The completion of an approved acceptance criteria is scheduled by August 31, 2007.
- Applicable transformer outage PM procedures will be revised to require Engineering review and trending of test data and to specify acceptance criteria for power factor (PF) and capacitance testing. Revisions of applicable procedures are scheduled to be revised as necessary by September 30, 2007.
- All available Doble data for transformers will be trended and access to the trend data provided on a common median. Scheduled completion date is September 30, 2007.
- An independent failure analysis of the failed bushing will be performed by an engineering contractor and the report results reviewed by engineering for any necessary corrective actions. Completion of engineering review is scheduled for November 2, 2007.
- An extent of condition was performed and concluded the issue is related to GE condenser Type U bushings which are only used on the main transformers. The 32 transformer has two GE Type U bushings but are of a newer design which is considered free from the issues with the original design. The replacement transformer has different high voltage bushings that have an improved design and have not experienced similar problems. Unit 2 has two new Siemens main transformers installed in 2006 with Type COTA bushings manufactured by Trench. This design is different from the GE Type U and there has been no industry issues with the COTA type bushing design.

Event Analysis

The event is reportable under 10CFR50.73(a)(2)(iv)(A). The licensee shall report any event or condition that resulted in manual or automatic actuation of any of the systems listed under 10CFR50.73(a)(2)(iv)(B). Systems to which the requirements of 10CFR50.73(a)(2)(iv)(A) apply for this event include the Reactor Protection System (RPS) including RT and AFWS actuation. This event meets the reporting criteria because an automatic RT was initiated at 1109 hours, on April 6, 2007, and the AFWS actuated as a result of the RT. The failure of the 31 main transformer did not result in the loss of any safety function. Two of three 138 kV offsite power breakers [Breaker F1 (Feeder 96951) and Breaker F7 (Feeder 95891)] to the Buchanan substation tripped as a result of the event. One offsite feeder (96952) to the Buchanan substation remained available therefore, there was no safety system functional failure reportable under 10CFR50.73(a)(2)(v). Subsequent to the RT at 1109 hours, operations was notified at approximately 2100 hours, that 138 kV offsite power breaker F1 (Feeder 96951) and breaker F7 (Feeder 95891) had opened and were subsequently closed at 1215 hours. Loss of the feeders required entry into Technical Specification (TS) Limiting Condition for Operation (LCO) 3.8.1 Condition A. TS 3.8.1 required action A.1, is to perform surveillance requirement SR 3.8.1.1 within one hour due to not having independent offsite power feeds into the Buchanan substation for Indian Point Energy Center's (IPEC) 138 kV and 13.8 kV offsite feeders. The IPEC control room operators had not complied with the TS requirement as they were not notified of the condition by the Con Edison District Operator. The failure to perform TS SR 3.8.1.1 was not a TS prohibited condition. As a result of the RT, the required action of TS 3.8.1 Condition F.1 to be in Mode 3 in six hours was met, and the completion of SR 3.8.1.1 did not require the action of F.2 (Mode 5 in 36 hours) as SR 3.8.1.1 was completed at 2135 hours.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Indian Point Unit 3	05000-286	2007	- 02	- 00	5 OF 5

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

PAST SIMILAR EVENTS

A review of the past two years of Licensee Event Reports (LERs) for events that involved a RT from a failure of the high voltage electric power system identified no applicable LERs.

Safety Significance

This event had no effect on the health and safety of the public. There were no actual safety consequences for the event because the event was an uncomplicated RT with no other transients or accidents. Required primary safety systems performed as designed when the RT was initiated. There were no risk related components out of service at the time of the RT. The AFWS actuation was an expected reaction as a result of low SG water level due to SG void fraction (shrink), which occurs after automatic RT from full load. The AFWS actuated and provided required FW flow to the SGs. The AFWS capacity is sufficient to provide the minimum required FW flow to the SGs. There were no significant potential safety consequences of this event under reasonable and credible alternative conditions. This event was bounded by the analyzed event described in FSAR Section 14.1.8, "Loss of External Electrical Load." RCS pressure remained below the set point for pressurizer PORV or code safety valve operation and above the set point for automatic safety injection actuation. Following the RT, the plant was stabilized in hot standby.